

## CLAIMS

What is claimed is:

1           1. A fiber optic module for coupling photons between  
2   optoelectronic devices and optical fibers, the fiber optic  
3   module comprising:

4           a base having a first, a second, a third and a fourth  
5   opening;

6           a first vertical printed circuit board (PCB) arranged  
7   parallel to a first optical axis of a first optoelectronic  
8   device, the first optoelectronic device having terminals  
9   coupled to the first vertical printed circuit board, the first  
10   vertical printed circuit board arranged perpendicular to the  
11   base, the first vertical printed circuit board having a  
12   plurality of pins extending through the first opening in the  
13   base to couple to a system;

14          a second vertical printed circuit board (PCB) arranged  
15   parallel to a second optical axis of a second optoelectronic  
16   device, the second optoelectronic device having terminals  
17   coupled to the second vertical printed circuit board, the  
18   second vertical printed circuit board arranged perpendicular  
19   to the base, the second vertical printed circuit board having  
20   a plurality of pins extending through the second opening in  
21   the base to couple to the system;

22          a third vertical printed circuit board (PCB) arranged  
23   parallel to a third optical axis of a third optoelectronic  
24   device, the third optoelectronic device having terminals  
25   coupled to the third vertical printed circuit board, the third  
26   vertical printed circuit board arranged perpendicular to the  
27   base, the third vertical printed circuit board having a  
28   plurality of pins extending through the third opening in the

29 base to couple to the system;  
30 a fourth vertical printed circuit board (PCB) arranged  
31 parallel to a fourth optical axis of a fourth optoelectronic  
32 device, the fourth optoelectronic device having terminals  
33 coupled to the fourth vertical printed circuit board, the  
34 fourth vertical printed circuit board arranged perpendicular  
35 to the base, the fourth vertical printed circuit board having  
36 a plurality of pins extending through the fourth opening in  
37 the base to couple to the system; and  
38 a shielded housing coupled to the base to encase the  
39 first vertical, second vertical, third vertical, and fourth  
40 vertical printed circuit boards to reduce electromagnetic  
41 interference (EMI).

1 2. The fiber optic module of claim 1 further comprising:  
2 an optical block coupled to the first, second, third and  
3 fourth optoelectronic devices, the optical block having  
4 a first, second, third and fourth openings to receive the  
5 first, second, third and fourth optoelectronic devices  
6 respectively, and  
7 a first, second, third, and fourth lens to couple photons  
8 between the first, second, third and fourth optoelectronic  
9 devices and first, second, third and fourth optical fibers  
10 respectively.

1 3. The fiber optic module of claim 2 further comprising:  
2 a nose coupled to the base, the nose to receive an  
3 optical fiber connector and to hold the first, second, third  
4 and fourth optical fibers substantially fixed and aligned with  
5 the first, second, third, and fourth optical openings of the  
6 optical block.

1 4. The fiber optic module of claim 3 further comprising:

2 a nose shield surrounding the nose to reduce  
3 electromagnetic interference.

1 5. The fiber optic module of claim 1 wherein,  
2 the third vertical printed circuit board and the third  
3 optoelectronic device and the fourth vertical printed circuit  
4 board and the fourth optoelectronic device to provide  
5 redundancy for the fiber optic module.

1 6. The fiber optic module of claim 1 wherein,  
2 the first vertical printed circuit board and the first  
3 optoelectronic device; the second vertical printed circuit  
4 board and the second optoelectronic device; the third vertical  
5 printed circuit board and the third optoelectronic device; and  
6 the fourth vertical printed circuit board and the fourth  
7 optoelectronic device to provide a four channel fiber optic  
8 module.

1 7. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:  
4 a base;  
5 at least a pair of vertical printed circuit boards  
6 arranged parallel to a first optical axis of a first  
7 optoelectronic device and parallel to a second optical axis of  
8 a second optoelectronic device respectively, the first  
9 optoelectronic device having terminals coupled to one of the  
10 vertical printed circuit boards and the second optoelectronic  
11 device having terminals coupled to another one of the vertical  
12 printed circuit boards, the at least pair of vertical printed  
13 circuit boards being arranged perpendicular to the base;  
14 at least a third printed circuit board (PCB) arranged  
15 parallel to a third optical axis of a third optoelectronic

16 device, the third optoelectronic device having terminals  
17 coupled to the third printed circuit board; and  
18 at least a fourth printed circuit board (PCB) arranged  
19 parallel to a fourth optical axis of a fourth optoelectronic  
20 device, the fourth optoelectronic device having terminals  
21 coupled to the fourth printed circuit board.

1 8. The fiber optic module of claim 7 further comprising:  
2 a housing coupled to the base.

1 9. The fiber optic module of claim 8 wherein,  
2 the housing is a shielded housing to encase the at least  
3 pair of vertical printed circuit boards and the at least third  
4 and the at least fourth printed circuit boards to reduce  
5 electromagnetic interference (EMI).

1 10 The fiber optic module of claim 7 further comprising:  
2 an optical block coupled to the first, second, third and  
3 fourth optoelectronic devices, the optical block having  
4 a first, second, third and fourth openings to receive the  
5 first, second, third and fourth optoelectronic devices  
6 respectively, and  
7 a first, second, third, and fourth lens to couple photons  
8 between the first, second, third and fourth optoelectronic  
9 devices and first, second, third and fourth optical fibers  
10 respectively.

1 11. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:  
4 a base having a first, a second, a third and a fourth  
5 opening;

6 a first horizontal printed circuit board (PCB) arranged  
7 parallel to a first optical axis of a first optoelectronic  
8 device, the first optoelectronic device having terminals  
9 coupled to the first horizontal printed circuit board, the  
10 first horizontal printed circuit board arranged parallel to  
11 the base, the first horizontal printed circuit board having a  
12 plurality of pins extending through the first opening in the  
13 base to couple to a system;

14 a second horizontal printed circuit board (PCB) arranged  
15 parallel to a second optical axis of a second optoelectronic  
16 device, the second optoelectronic device having terminals  
17 coupled to the second horizontal printed circuit board, the  
18 second horizontal printed circuit board arranged parallel to  
19 the base, the second horizontal printed circuit board having a  
20 plurality of pins extending through the second opening in the  
21 base to couple to the system;

22 a third horizontal printed circuit board (PCB) arranged  
23 parallel to a third optical axis of a third optoelectronic  
24 device, the third optoelectronic device having terminals  
25 coupled to the third horizontal printed circuit board, the  
26 third horizontal printed circuit board arranged parallel to  
27 the base, the third horizontal printed circuit board having a  
28 plurality of pins extending through the third opening in the  
29 base to couple to the system;

30 a fourth horizontal printed circuit board (PCB) arranged  
31 parallel to a fourth optical axis of a fourth optoelectronic  
32 device, the fourth optoelectronic device having terminals  
33 coupled to the fourth horizontal printed circuit board, the  
34 fourth horizontal printed circuit board arranged parallel to  
35 the base, the fourth horizontal printed circuit board having a  
36 plurality of pins extending through the fourth opening in the  
37 base to couple to the system; and

38 a shielded housing coupled to the base to encase the

39 first horizontal, second horizontal, third horizontal, and  
40 fourth horizontal printed circuit boards to reduce  
41 electromagnetic interference (EMI).

1        12 The fiber optic module of claim 11 further  
2 comprising:  
3        an optical block coupled to the first, second, third and  
4 fourth optoelectronic devices, the optical block having  
5        a first, second, third and fourth openings to receive the  
6 first, second, third and fourth optoelectronic devices  
7 respectively, and  
8        a first, second, third, and fourth lens to couple photons  
9 between the first, second, third and fourth optoelectronic  
10 devices and first, second, third and fourth optical fibers  
11 respectively.

1        13. The fiber optic module of claim 12 further  
2 comprising:  
3        a nose coupled to the base, the nose to receive an  
4 optical fiber connector and to hold the first, second, third  
5 and fourth optical fibers substantially fixed and aligned with  
6 the first, second, third, and fourth optical openings of the  
7 optical block.

1        14. The fiber optic module of claim 13 further  
2 comprising:  
3        a nose shield surrounding the nose to reduce  
4 electromagnetic interference.

1        15. The fiber optic module of claim 11 wherein,  
2 the third horizontal printed circuit board and the third  
3 optoelectronic device and the fourth horizontal printed

4 circuit board and the fourth optoelectronic device to provide  
5 redundancy for the fiber optic module.

1 16. The fiber optic module of claim 11 wherein,  
2 the first horizontal printed circuit board and the first  
3 optoelectronic device; the second horizontal printed circuit  
4 board and the second optoelectronic device; the third  
5 horizontal printed circuit board and the third optoelectronic  
6 device; and the fourth horizontal printed circuit board and  
7 the fourth optoelectronic device to provide a four channel  
8 fiber optic module.

1 17. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:

4 a base having a first, a second, a third and a fourth  
5 opening;

6 a first vertical printed circuit board (PCB) arranged  
7 parallel to a first optical axis of a first optoelectronic  
8 device, the first optoelectronic device having terminals  
9 coupled to the first vertical printed circuit board, the first  
10 vertical printed circuit board arranged perpendicular to the  
11 base, the first vertical printed circuit board having a  
12 plurality of pins extending through the first opening in the  
13 base to couple to a system;

14 a second vertical printed circuit board (PCB) arranged  
15 parallel to a second optical axis of a second optoelectronic  
16 device, the second optoelectronic device having terminals  
17 coupled to the second vertical printed circuit board, the  
18 second vertical printed circuit board arranged perpendicular  
19 to the base, the second vertical printed circuit board having  
20 a plurality of pins extending through the second opening in  
21 the base to couple to the system;

22 a third horizontal printed circuit board (PCB) arranged  
23 parallel to a third optical axis of a third optoelectronic  
24 device, the third optoelectronic device having terminals  
25 coupled to the third horizontal printed circuit board, the  
26 third horizontal printed circuit board arranged parallel to  
27 the base, the third horizontal printed circuit board having a  
28 plurality of pins extending through the third opening in the  
29 base to couple to the system;

30 a fourth horizontal printed circuit board (PCB) arranged  
31 parallel to a fourth optical axis of a fourth optoelectronic  
32 device, the fourth optoelectronic device having terminals  
33 coupled to the fourth horizontal printed circuit board, the  
34 fourth horizontal printed circuit board arranged parallel to  
35 the base, the fourth horizontal printed circuit board having a  
36 plurality of pins extending through the fourth opening in the  
37 base to couple to the system; and

38 a shielded housing coupled to the base to encase the  
39 first vertical, second vertical, third horizontal, and fourth  
40 horizontal printed circuit boards to reduce electromagnetic  
41 interference (EMI).

1 18 The fiber optic module of claim 17 further  
2 comprising:

3 an optical block coupled to the first, second, third and  
4 fourth optoelectronic devices, the optical block having

5 a first, second, third and fourth openings to receive the  
6 first, second, third and fourth optoelectronic devices  
7 respectively, and

8 a first, second, third, and fourth lens to couple photons  
9 between the first, second, third and fourth optoelectronic  
10 devices and first, second, third and fourth optical fibers  
11 respectively.

1        19. The fiber optic module of claim 18 further  
2 comprising:

3        a nose coupled to the base, the nose to receive an  
4 optical fiber connector and to hold the first, second, third  
5 and fourth optical fibers substantially fixed and aligned with  
6 the first, second, third, and fourth optical openings of the  
7 optical block.

1        20. The fiber optic module of claim 19 further  
2 comprising:

3        a nose shield surrounding the nose to reduce  
4 electromagnetic interference.

1        21. The fiber optic module of claim 17 wherein,  
2 the second vertical printed circuit board and the second  
3 optoelectronic device and the fourth horizontal printed  
4 circuit board and the fourth optoelectronic device to provide  
5 redundancy for the fiber optic module.

1        22. The fiber optic module of claim 17 wherein,  
2 the first vertical printed circuit board and the first  
3 optoelectronic device; the second vertical printed circuit  
4 board and the second optoelectronic device; the third  
5 horizontal printed circuit board and the third optoelectronic  
6 device; and the fourth horizontal printed circuit board and  
7 the fourth optoelectronic device to provide a four channel  
8 fiber optic module.

1        23. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:

4 a base having a first, a second, and a third opening;  
5 a first vertical printed circuit board (PCB) arranged  
6 parallel to a first optical axis of a first optoelectronic  
7 device, the first optoelectronic device having terminals  
8 coupled to the first vertical printed circuit board, the first  
9 vertical printed circuit board arranged perpendicular to the  
10 base, the first vertical printed circuit board having a  
11 plurality of pins extending through the first opening in the  
12 base to couple to a system;  
13 a second vertical printed circuit board (PCB) arranged  
14 parallel to a second optical axis of a second optoelectronic  
15 device, the second optoelectronic device having terminals  
16 coupled to the second vertical printed circuit board, the  
17 second vertical printed circuit board arranged perpendicular  
18 to the base, the second vertical printed circuit board having  
19 a plurality of pins extending through the second opening in  
20 the base to couple to the system;  
21 a third horizontal printed circuit board (PCB) arranged  
22 parallel to a third optical axis of a third optoelectronic  
23 device and a fourth optical axis of a fourth optoelectronic  
24 device, the third and fourth optoelectronic devices each  
25 having terminals coupled to the third horizontal printed  
26 circuit board, the third horizontal printed circuit board  
27 arranged parallel to the base, the third horizontal printed  
28 circuit board having a plurality of pins extending through the  
29 third opening in the base to couple to the system; and  
30 a shielded housing coupled to the base to encase the  
31 first vertical, second vertical, and third horizontal printed  
32 circuit boards to reduce electromagnetic interference (EMI).

1 24. The fiber optic module of claim 23 further  
2 comprising:

3 an optical block coupled to the first, second, third and

4 fourth optoelectronic devices, the optical block having  
5 a first, second, third and fourth openings to receive the  
6 first, second, third and fourth optoelectronic devices  
7 respectively, and  
8 a first, second, third, and fourth lens to couple photons  
9 between the first, second, third and fourth optoelectronic  
10 devices and first, second, third and fourth optical fibers  
11 respectively.

1 25. The fiber optic module of claim 24 further  
2 comprising:

3 a nose coupled to the base, the nose to receive an  
4 optical fiber connector and to hold the first, second, third  
5 and fourth optical fibers substantially fixed and aligned with  
6 the first, second, third, and fourth optical openings of the  
7 optical block.

1 26. The fiber optic module of claim 25 further  
2 comprising:

3 a nose shield surrounding the nose to reduce  
4 electromagnetic interference.

1 27. The fiber optic module of claim 24 wherein,  
2 the second vertical printed circuit board and the second  
3 optoelectronic device and the fourth optoelectronic device to  
4 provide redundancy for the fiber optic module.

1 28. The fiber optic module of claim 24 wherein,  
2 the first vertical printed circuit board and the first  
3 optoelectronic device; the second vertical printed circuit  
4 board and the second optoelectronic device; and the third  
5 horizontal printed circuit board and the third optoelectronic

6 device and the fourth optoelectronic device to provide a four  
7 channel fiber optic module.

1 29. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:

4 a base having a first, a second, a third and a fourth  
5 opening;

6 a first vertical printed circuit board (PCB) arranged  
7 parallel to a first optical axis of a first optoelectronic  
8 device, the first optoelectronic device having terminals  
9 coupled to the first vertical printed circuit board, the first  
10 vertical printed circuit board arranged perpendicular to the  
11 base, the first vertical printed circuit board having a  
12 plurality of pins extending through the first opening in the  
13 base to couple to a system;

14 a second vertical printed circuit board (PCB) arranged  
15 parallel to a second optical axis of a second optoelectronic  
16 device, the second optoelectronic device having terminals  
17 coupled to the second vertical printed circuit board, the  
18 second vertical printed circuit board arranged perpendicular  
19 to the base, the second vertical printed circuit board having  
20 a plurality of pins extending through the second opening in  
21 the base to couple to the system;

22 a third vertical printed circuit board (PCB) arranged  
23 parallel to a third optical axis of a third optoelectronic  
24 device, the third optoelectronic device having terminals  
25 coupled to the third vertical printed circuit board, the third  
26 vertical printed circuit board arranged perpendicular to the  
27 base, the third vertical printed circuit board having a  
28 plurality of pins extending through the third opening in the  
29 base to couple to the system;

30 a fourth horizontal printed circuit board (PCB) arranged

31 parallel to a fourth optical axis of a fourth optoelectronic  
32 device, the fourth optoelectronic device having terminals  
33 coupled to the fourth horizontal printed circuit board, the  
34 fourth horizontal printed circuit board arranged parallel to  
35 the base, the fourth horizontal printed circuit board having a  
36 plurality of pins extending through the fourth opening in the  
37 base to couple to the system; and

38 a shielded housing coupled to the base to encase the  
39 first vertical, second vertical, third vertical, and fourth  
40 horizontal printed circuit boards to reduce electromagnetic  
41 interference (EMI).

1 30. The fiber optic module of claim 29 further  
2 comprising:

3 an optical block coupled to the first, second, third and  
4 fourth optoelectronic devices, the optical block having  
5 a first, second, third and fourth openings to receive the  
6 first, second, third and fourth optoelectronic devices  
7 respectively, and

8 a first, second, third, and fourth lens to couple photons  
9 between the first, second, third and fourth optoelectronic  
10 devices and first, second, third and fourth optical fibers  
11 respectively.

1 31. The fiber optic module of claim 30 further  
2 comprising:

3 a nose coupled to the base, the nose to receive an  
4 optical fiber connector and to hold the first, second, third  
5 and fourth optical fibers substantially fixed and aligned with  
6 the first, second, third, and fourth optical openings of the  
7 optical block.

1 32. The fiber optic module of claim 31 further

2 comprising:

3 a nose shield surrounding the nose to reduce  
4 electromagnetic interference.

1 33. The fiber optic module of claim 29 wherein,  
2 the second vertical printed circuit board and the second  
3 optoelectronic device and the fourth horizontal printed  
4 circuit board and the fourth optoelectronic device to provide  
5 redundancy for the fiber optic module.

1 34. The fiber optic module of claim 29 wherein,  
2 the first vertical printed circuit board and the first  
3 optoelectronic device; the second vertical printed circuit  
4 board and the second optoelectronic device; the third vertical  
5 printed circuit board and the third optoelectronic device; and  
6 the fourth horizontal printed circuit board and the fourth  
7 optoelectronic device to provide a four channel fiber optic  
8 module.

1 35. A fiber optic module for coupling photons between  
2 optoelectronic devices and optical fibers, the fiber optic  
3 module comprising:

4 a base;

5 at least a pair of vertical printed circuit boards  
6 arranged parallel to a first optical axis of a first  
7 optoelectronic device and parallel to a second optical axis of  
8 a second optoelectronic device respectively, the first  
9 optoelectronic device having terminals coupled to one of the  
10 vertical printed circuit boards and the second optoelectronic  
11 device having terminals coupled to another one of the vertical  
12 printed circuit boards, the at least pair of vertical printed  
13 circuit boards being arranged perpendicular to the base and  
14 having a first and second electrical connectors to plug into

15 and out of an electrical connector of a host printed circuit  
16 board;

17 at least a third printed circuit board (PCB) arranged  
18 parallel to a third optical axis of a third optoelectronic  
19 device, the third optoelectronic device having terminals  
20 coupled to the at least third printed circuit board, the at  
21 least third printed circuit board having a third electrical  
22 connector to plug into and out of an electrical connector of  
23 the host printed circuit board; and

24 at least a fourth printed circuit board (PCB) arranged  
25 parallel to a fourth optical axis of a fourth optoelectronic  
26 device, the fourth optoelectronic device having terminals  
27 coupled to the fourth printed circuit board, the at least  
28 fourth printed circuit board having a fourth electrical  
29 connector to plug into and out of an electrical connector of  
30 the host printed circuit board.

1 36. The fiber optic module of claim 35 further  
2 comprising:

3 a housing coupled to the base.

1 37. The fiber optic module of claim 36 wherein,  
2 the housing is a shielded housing to encase the at least  
3 pair of vertical printed circuit boards and the at least third  
4 and the at least fourth printed circuit boards to reduce  
5 electromagnetic interference (EMI).

1 38 The fiber optic module of claim 35 further  
2 comprising:

3 an optical block coupled to the first, second, third and  
4 fourth optoelectronic devices, the optical block having  
5 a first, second, third and fourth openings to receive the  
6 first, second, third and fourth optoelectronic devices

7    respectively, and  
8           a first, second, third, and fourth lens to couple photons  
9    between the first, second, third and fourth optoelectronic  
10   devices and first, second, third and fourth optical fibers  
11   respectively.

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